RADIOLOGY OF THE FIRST PART OF THE DUODENUM

By L. S. CARSTAIRS, M.B., B.S., M.R.C.S., L.R.C.P., D.M.R.

Consultant Radiologist, Royal Northern Hospital

Introduction

In the positive diagnosis of lesions in the first part of the duodenum, the radiologist has a virtual monopoly, and it is a happy chance that with the increasing resort to surgery for the alleviation of duodenal ulceration there is a constantly recurring stimulus to more accurate diagnosis. This stimulus is not confined to the discovery of pathology. It has become equally important to be able to say that no pathology exists.

It might be said that there has been in the past a tendency on the part of the radiologist to over diagnose, to create suspicion based on the presence of such signs as pylorospasm, localized tenderness and the heavy pressure of a typical history. But less than justice is done to the patient by such inferential criteria, and the door of an alternative and possibly more serious diagnosis should be left open. It is now generally agreed that the only evidence that can be accepted for the presence of a duodenal ulcer at the time of the examination is the demonstration of its crater. Naturally, if a duodenal cap is the site of cicatricial change that would be evidence that ulceration had been present. Such a condition would be declared, but if an ulcer crater cannot be shown, it is no part of the radiologist's function to bridge the gap between objective signs and clinical deduction and to say that 'there is chronic duodenal ulceration.'

However, to complicate this direct approach to the problem there is an opinion that symptoms similar to those of ulceration may be produced by psychosomatic imbalance without ulceration being present. This opinion has as its basis the not unreasonable hypothesis that mental stress beyond the limits of endurance of a particular individual can be regarded as one of the major factors in the aetiology of duodenal ulceration. In these patients it is supposed that there will be changes in the duodenum evident to a radiologist but short of ulceration. It is arguable that these changes are, in fact, what has been described as duodenitis. Arising from this approach there is a tendency to ask only of the radiologist an assurance that there

is no lesion in the lower oesophagus or stomach, that gall bladder function is normal and that the first part of the duodenum is not completely normal. This is a tempting but dangerous bait for the radiologist. To take it would mean a return to inference in the diagnosis of duodenal abnormality, and almost certainly a lowering of the accuracy level which each radiologist must make for himself. Also, with the widespread dissemination of medical knowledge which is now under way, anxiety over ulceration may be the final stress in its precipitation and firm assurance that the duodenum is not demonstratively ulcerated may be of therapeutic value. This assurance cannot be honestly given unless adequate criteria have been set and fulfilled. If this has been done the examination will have been performed in such a way that an organic lesion will have been discovered, in the great majority of patients, if it is present. A description can be made and the clinician may draw what conclusions he will.

Implicit in all objective reporting by one person to another is the necessity for a good relationship and a mutual understanding of problems and terminology. Radiological jargon has worked its way into general medicine and it is not unusual to find such terms as 'en face' and 'profile' being freely used but not understood. It is therefore proposed to describe the technique commonly employed in the radiological examination of the first part of the duodenum at some length. Before doing so a word regarding the apparatus required will not be out of place.

In the opinion of most workers it is essential that films of the duodenal cap should be taken during the examination by the radiologist. Taken in certain projections and in ways that experience dictates they frequently provide confirmation of an impression obtained, and not infrequently provide information which was entirely missed, during screening. They are available for future comparison and assessment of progress. It is necessary to be able to tilt the patient from the erect to the Trendelenburg position. The films obtained

(a) En face view.

PLATE I

(b) Profile view

must be sharp and the exposure time preferably below one-third of a second. The apparatus, therefore, is complicated and expensive, costing, with installation charges, some £3,000 to £5,000. It is here that, in hospital practice, the radiologist's colleagues can be of assistance in ensuring that his case for improved apparatus obtains their general support.

It is perhaps unnecessary to say that with an average time of 15 min. for each examination initially, there is a limit to the number of patients that one can see without losing efficiency. Good sorting of cases and the avoidance of the routine diagnostic 'work-up' will produce a satisfying selection of positive and negative findings and obviate that procession of patients in whom no abnormality can be found which is so inimical to the maintenance of interest and accuracy.

Technique

The examination of the first part of the duodenum, which will for the sake of brevity be called the duodenal cap, is closely linked with that of the stomach. In a generally accepted routine it falls into two parts. The first occurs during the preliminary demonstration of the gastric mucosal pattern. The patient, having swallowed a mouthful of a fine barium suspension while in the erect

position, is transferred to the supine position on the tilting table. He is then turned on to his right side. In the majority of people, the barium will pass into the duodenal cap if it has not already done so. He is then turned slowly on to his back and then slightly on to his left side. During this procedure the air in the fundus travels to and slightly distends the antrum and frequently passes into the duodenal cap. A film is taken immediately. In not a few cases this preliminary film, which is primarily designed to demonstrate the mucosal pattern of the posterior wall of the stomach, will provide important information concerning the duodenal cap. Secondly, the study of the cap commences after the examination of the stomach has been completed. The patient is standing.

In the average patient the duodenal cap proceeds upwards, slightly to the right and slightly posteriorly, from the pylorus. In the posterior anterior axis of inspection, therefore, it may be obscured by the second part of the duodenum descending behind it, while the superior duodenal flexure is seen 'end-on.' Consequently it is desirable to unfold these parts relative to the observer. To do this the patient, who is standing facing the observer, is turned, the patient's right shoulder being brought closer to the observer, until complete separation has been achieved, and the cap is seen clearly throughout its course. This position

produces what is called the 'en face' view of the cap (Plate 1a).

During the examination of the cap, a compression cone is used. This consists of a radio-lucent rounded cone which may be of several sizes and shapes, mounted on the fluorescent screen and capable of being applied to the patient's abdomen with varying degrees of pressure. The examining hand encased in a lead rubber glove is not a complete substitute, since when compression is thus applied the radio-opaque glove obscures the portion compressed. Films are obtained of the cap in full distension, during emptying and in full distension with compression, so that its mucosal pattern can be observed.

The patient is then turned so that an axis of inspection approximately at right angles to that of the 'en face' view is obtained, his left shoulder being brought closer to the observer. This view provides an outline of the anterior and posterior walls of the cap. Often it is necessary to turn the patient until the shadow of the cap disappears behind the shadow of body of the stomach. Then the compression cone is applied while the patient breathes in and the stomach descends. Pressure is maintained while the patient breathes out. The stomach is to a certain extent held downwards and backwards while the duodenal cap is free to rise and its posterior wall becomes visible. Films are taken in several degrees of rotation and in several phases of filling and emptying, the object being to demonstrate the ulcer crater as a constant projection of barium beyond the confines of the mucosal margin of the lumen and in certain cases to produce evidence, quite invisible on the screen to the observer, of a constant gas-filled pouch which represents the true size of the ulcer crater. This, then, is called the 'profile' view of the cap (Plate 1b).

In the majority of cases the examination of the cap will now be at an end. Accessory methods of investigation, however, become essential in certain types of individual. In some, there is such rapid flooding of the duodenal loop and jejunum, and the jejunum is in such a position that it obscures the cap in the 'en face' view, that adequate separation of the cap from other structures is difficult. In some the cap is high in position and inaccessible to compression or palpation. As an example may be taken the heavily built, deep-chested man with a protuberant abdomen whose symptoms could be cardiac, aortic, biliary, oesophageal or peptic in origin. If the clinician considers that his recent symptoms may be due to duodenal ulceration, nothing short of an earnest attempt to demonstrate the mucosal pattern in the cap will suffice. This patient's stomach will

probably lie transversely across the upper abdomen with the duodenal cap proceeding directly posteriorly from the pylorus and often indeed pointing slightly downwards, covered by costal cartilages and completely unapproachable by compression or palpation. Because of the patient's size and the limitations imposed by skin tolerance to radiation the visualization obtained on the fluorescent screen is poor. First one must get as good an outline of the whole of the cap and superior flexure as possible and second, some sort of demonstration of the mucosal lining. These patients hold several severe hazards for the radiologist. They are liable to have ulcer craters in undeformed caps as any other. They may hide their penetrating ulcers, and their basal pouches secondary to stenosis of the middle third of the cap may simulate, because of the relative positions, a normal duodenal cap on screen examination and on routine films.

Full demonstration of the outline of the cap and superior flexure may require that the patient be turned into the lateral position with his right shoulder towards the observer, or that he be placed in a position of right lateral decubitus with his left shoulder towards the observer, the shadow of the cap being thrown behind that of the stomach. It may also be of advantage to wait until the stomach is almost empty, manoeuvre by positioning some barium into the cap, and then pressing directly on to the pylorus, an 'axial' view of the cap can be obtained free from the overlying shadow of the barium filled antrum.

Of great value, however, in all cases of difficulty is to transfer air from the fundus of the stomach to the duodenal cap while the patient is in the supine position, and then to inspect and obtain films of the air-distended cap. Since barium is present, it will form a thin coating on the mucous membrane and the procedure may correctly be termed a double contrast method. As was originally stated, it is achieved in the routine film for the gastric mucosal pattern. It is also present in the routine supine oblique film taken in the Trendelenburg position during the examination of the stomach. Aimed films are, however, of more value and several of these are taken in varying positions, the patient being turned alternately on to his left and right sides to maintain the necessary quantities of air and barium in the cap.

Normal Findings and Variations

The first part of the duodenum extends from the pylorus to the superior duodenal flexure. In its common form in young adults it forms a tube which in full distension has an approximately uniform calibre and whose walls maintain

parallel course. At rest, when the pylorus is closed and there is contraction of the flexure, it is cone shaped. During peristalsis it is subject to the normal process of distension, contraction and relaxation and films taken at such times and examined 'out of context' may be misleading. The duodenal mucosa, as elsewhere in the alimentary tract, is of sufficient size to line the muscular tube when this is dilated to its maximum extent. And, being a relatively inelastic and non-contractile structure, as compared with the muscular tube, it of necessity falls into folds in the collapsed or partially distended state. There is a submucous layer of connective tissue containing a layer of smooth muscle fibres which presumably have as their function the maintenance of a state of 'tone' in the mucosa, and are partly responsible for the rapidity with which the mucosal folds alter their thickness and shape during peristalsis. It is also said that these muscle fibres would tend to keep the oedematous mucosa surrounding an ulcer heaped up, so that the crater was partially sealed off from the lumen.

The direction of the axis of the lumen is usually upwards, backwards and to the right. This is subject to considerable variation dependent on the anatomical living room which the stomach and duodenum inhabits. In the broad and deep-chested individual the duodenal cap tends to point more directly backwards, and in some its axis is horizontal and it proceeds directly posteriorly from the pylorus. On occasion the pylorus in a normal individual lies in the mid-line or slightly to the left, while in large hiatal herniae and eventration of the diaphragm, it is often well to the left and high in position so that the axis of cap is downwards and to the right. In some individuals the first part of the duodenum is extremely long and in the erect position it forms a smooth curve convex downwards. In consequence there is an apparently constant deformity close to the base of the cap with secondary alteration to the mucosal pattern at this site. These appearances may simulate a cicatricial deformity due to ulceration. On the other hand such 'looped caps' are not exempt from ulceration.

The duodenal cap is very variable in size. Small caps are not necessarily pathological while the very large and frequently atonic caps which are given the descriptive name of 'Megabulbus,' whilst not in themselves significant, may be very difficult to examine and demonstrate satisfactorily.

Occasionally the pylorus lies lateral to the cap, the axis of the pyloric antrum bending sharply backwards and to the left, but such a finding would automatically invite a search for some pre-existing cause of adhesion formation such as cholecystectomy, peritonitis or laparotomy.

Being closely invested by the other abdominal organs and peritoneal reflections the cap may be deformed constantly by the pressure of the adjacent gall bladder, and there is sometimes encountered deformities which are explicable by pressure from a dilated common bile duct during compression studies or by the congenital abnormality known as the hepato-duodenal lig. The latter deformity should not be lightly accepted, as a similar appearance may be produced by ulceration.

Finally, there may be a reversal of the normal duodenal curve the essential feature of which is that flow of the opaque medium in the second part of the duodenum is upwards towards the head instead of downwards. This is called 'duodenum inversum.' Gross degrees of 'looped cap' may produce a similar appearance, but in these the flow in the second part is normal in direction.

It may not be properly within the province of this article to discuss the physiological processes engaged in gastric emptying, but it is necessary to point out that the very high density fluid medium used in radiological examination does not completely represent the conditions maintaining during the taking of a normal meal. During the radiological examination a considerable part is played in the initial emptying of the stomach by simple hydrostatic pressure. Indeed, with the normal isotonic stomach, maintaining a column of barium in its body some 3 or 4 in. higher than the corresponding column in the pyloric antrum, there has to be a very firm control at the pylorus to prevent a rapid outflow of barium and the equalization of the heights of the two columns. Pyloric control is supplemented by tonic contraction of the distal portion of the duodenal cap and the 'cone' shape, so commonly referred to, is thus obtained. In few normal stomachs is the peristaltic wave concerned in the positive onward transmission of fluid contents. These peristaltic waves seldom close the lumen of the antrum and therefore cannot exert pressure on fluid lying above them. They do, however, intermittently pass through the pylorus, and the pyloric sphincter and distal portion of the cap open, not so much as a result of increased intraluminal pressure ahead of a peristaltic wave but rather during the phase of relaxation which follows it.

The concept of pylorospasm as an indication and concomitant of duodenal ulceration is a familiar one. But certainly it is as common in the nervous individual without ulceration as it is in a patient with ulceration. It is also remarkable how, in an individual who, for want of a better word, one describes as 'nervous,' and in whom marked initial pylorospasm is found, simple manoeuvres will result in the pylorus relaxing. These consist entirely of providing a distraction such as rotating

PLATE 2.—Fig. 1, normal mucosal pattern. Fig. 2, alteration in pattern during compression. Fig. 3, alteration in pattern during peristalsis. Fig. 4, double contrast film; normal. Fig. 5, cicatricial and mucosal deformity; no ulcer shown. Fig. 6, en face and profile views in full distension are negative, but ulcer crater shown in en face view on compression and in profile view on contraction. Fig. 7, undeformed cap with crater shown on compression. Fig. 8, minimal deformity of base of cap; juxta-pyloric D.U. shown on compression. Fig. 9, "kissing" ulcers; the craters overlap in one film but are separated by slight rotation. Fig. 10, profile view of deformed cap, no crater seen; 11 months later a posterior wall crater is demonstrated. Fig. 11, girl aged 18 years; symptoms for two years; posterior wall crater shown; eight months later no crater visible. Fig. 12, anterior wall crater shown in en face and profile views; five months later no ulcer seen and mucosal pattern apparently normal (see text). Fig. 13, en face view of a deep flat crater on the anterior wall and the subsequent scarring. Fig. 14, an extrinsic pressure defect on cap. Figs. 15 and 16, incisurae on margins of the cap; no mucosal scarring found; presumed to be due to abnormal peritoneal reflections. Fig. 17, a similar incisura, but shown on compression to be due to ulceration. Fig. 18, duodeno-biliary fistula.

PLATE 3.—Fig. 19, anterior wall penetrating crater with air/fluid/barium levels. Fig. 20, superior border penetrating crater with air/barium level. Fig. 21, crater adherent to pancreas, 'V' shaped deformity. Fig. 22, crater adherent to pancreas, 'V' shaped deformity. Fig. 23, crater at junction of first and second parts of the duodenum, adherent to pancreas. Fig. 24, the dilated proximal portion of the cap simulates a normal posteriorly directed cap. Double contrast and axial films show a crater which is adherent to pancreas. Figs. 25, 26 and 27, three cases of duodenal stenosis, post ulcerative; note the dilated pyloric rings; Fig. 28, an adherent lesser curve crater. Fig. 29, funneling of the base of the cap, juxta-pyloric D.U.; in the profile film the crater lies anteriorly but is overlaid by the base of the cap. Fig. 30, minimal deformity of the base of the cap; juxta-pyloric D.U. shown on compression. Fig. 31, a large posterior penetrating ulcer at the pylorus. Fig. 32, asymmetrical base of cap; juxta-pyloric D.U. shown on compression. Fig. 33, deformity of the base of cap produced by pyloric neoplasm. Fig. 34, asymmetrical base of cap due to lesser curve fibrosis from gastric ulcer (purse bag stomach). Fig. 35, double contrast film showing an obliquely placed base of cap under compression; may be confused with gastric mucosal prolapse. Fig. 36, an appearance suggesting duodenitis; the profile film shows a small posterior wall crater. Fig. 37, irregular mucosal swelling without evidence of ulceration; appearances unaltered at subsequent examinations; no changes in stomach. Fig. 38, a similar case to Fig. 37; both labelled duodenitis. Fig. 39, 11 years after gastrectomy at which a large crater adherent to pancreas had to be left behind, this rigid crater is shown on filling of the afferent limb. Fig. 40, two sessile duodenal polypi. Fig. 41, a pedunculated duodenal polyp.

the patient and compressing his left abdomen as for a profile film, forced inspiration and expiration and, experimentally, most effective of all, some sudden shock, such as the slamming of a door or other loud noise.

In cases of ulceration, the association of mucosal oedema, fibrosis and true spasm may change a tonically contracted pylorus into a relatively impassable barrier. It is, however, important to realize that in many cases of gastric dilatation with retention of secretions and foodstuffs consequent on duodenal ulceration, the pylorus is widely patent and the stenosis is duodenal in level and not pyloric; the identification of this dilated pylorus forming an important diagnostic feature in the differential diagnosis from pyloric obstruction due to neoplasm.

Criteria for Normality

In the present state of our knowledge, the first part of duodenum may be said to be normal if:

1. Its position, size and shape corresponds to one of the recognized non-pathological types or variations.
2. It presents no abnormality in contour during full distension or if such an abnormality is present, it can be accounted for by an external agency.
3. It presents no evidence of internal abnormal structures.
4. It presents a normal mucosal pattern throughout.

It is in respect of the last that, in certain cases, radiographic diagnosis becomes most difficult. There is little doubt that until such time as direct inspection of the duodenal mucosa is practicable, these criteria will stand. They may, however, undergo amplification.

The normal variations in position, size and shape have already been described and the deformities due to external agents have been mentioned. A constant intrinsic deformity, however, does not always indicate past duodenal ulceration. The spreading fibrosis and traction resulting from fibrosis of the lesser curvature of the stomach due to gastric ulceration (purse-bag or snail-rolling) may well simulate a primary duodenal fibrosis. Ulceration in the pyloric canal or immediately proximal to it may produce a funnel-shaped deformity of the base of the cap. Other causes of intramural and periduodenal fibrosis are: Sequelae to perforated gastric ulcer, cholecystectomy and peritonitis from any cause. Traction on the cap with elongation and deformity may result from volvulus of the stomach, eventration, diaphragmatic hernia and large masses in the region of, or in, the pancreas.

Intrinsic tumours of the cap may be simulated by deep rounded incisurae resulting from old

ulceration or peritoneal reflections, air bubbles in the barium mixture, solid radiolucent bodies such as fruit stones and pedunculated gastric polyp which have prolapsed through the pylorus.

The normal mucosal pattern consists of parallel folds running in the long axis of the cap which undergo changes in thickness and direction during peristalsis. Mistakes may occur when isolated films taken during peristalsis are examined out of context. The mucosal folds are often continuous with those in the pyloric canal and antrum and if the pyloric canal is photographed under compression and at an angle, the impression may be gained that prolapse of gastric mucosa has occurred. Although this condition undoubtedly occurs, the high incidence found by some observers is not generally accepted.

Demonstration of the mucosal folds may be obtained by compression during full distension or by the method of double contrast described. In either case there is a danger that it will not be appreciated that the folds demonstrated are mainly those of the posterior wall. Fig. 12 shows an apparent return to normal after an undoubted anterior wall ulcer had been demonstrated. The scar on the anterior wall was, however, subsequently shown. Had this patient been X-rayed elsewhere on the first occasion, one would have been tempted to doubt the veracity of the report. In cases of difficulty in demonstration there may be a large expenditure of time and materials and in the end all one's efforts may be negated by the presence of barium-filled jejunum which obscures the cap at every turn. In such cases it may be helpful to start afresh after a few days, taking films immediately when the patient has swallowed only a small quantity of barium and before this has passed beyond the third part of the duodenum. If, then, for any reason the radiologist has failed to demonstrate the mucosa and the cap is otherwise normal, he may content himself with reporting the facts and stating that the duodenal cap was undeformed by cicatricial changes and that no evidence of ulceration could be obtained. A proper appreciation of what such a report implies should be possible on the clinical side and can only be obtained by a reasonable liaison between the persons concerned.

The Radiological Appearances of Duodenal Ulceration

The cardinal feature is the ulcer crater. In its absence deformity and or mucosal scarring only indicates that ulceration has been present. In the explanation of symptoms of several years duration, other things being equal, the clinician may assume correctly that cicatricial changes indicate that the patient's symptoms have been, and still are, due

to a duodenal ulcer. It is not, however, a justifiable assumption for the radiologist. The temptation to point to any minute fleck of barium situated in the region of a radiating mucosal scar and say that this is the ulcer has to be resisted.

With the earlier recourse to radiology an increasing number of cases of ulceration without deformity of the cap is being found. Such caps are fully distensible, undergo normal peristalsis and, apart from the presence of an ulcer crater and surrounding oedema, can be normal in every other respect. The amount of oedema present will depend on the time interval between the onset of ulceration and the examination and on any medication or dietary measures taken in the interim. Generally speaking, oedema is maximal shortly after ulceration has occurred and thereafter diminishes. Mucosal deformity may be found without alteration in the muscular wall, that is without a deformed cap. It is possible to have a large ulcer with surrounding oedema in a cap whose outline and distensibility are unimpaired in a patient whose symptoms have been present for four months. It will be appreciated that such terms as clover leaf deformity, trefoil deformity, etc., while good descriptively, tend to mislead the reader into believing that they are essential features, whereas they are only the result of prolonged ulceration. It would be rare to find an undeformed cap in a patient with a year's history, but this deformity may be slight and its degree will bear a relation to the number of abortive or inadequate attempts at therapy.

The radiographic appearances of duodenal ulceration may for convenience be tabulated as follows:

(a) The recent ulcer in an undeformed or spasmodically deformed cap, surrounded by a circular pad of oedema which increases the apparent depth of the crater in the profile view.

(b) An ulcer crater with mucosal scarring as shown by the constant radiating furrows in which barium is retained during compression. Oedema is present to a greater or less extent.

(c) Cicatricial changes in the duodenal wall, as evidenced by a deformity of the outline of the cap which persists unaltered in full distension and under compression. The general rule is that the ulcer crater, being the initiating site of the fibrosis, will be found at the narrowest portion of the lumen of the cap.

(d) Penetration of the ulcer into the muscular coat associated with a peritoneal reaction, so that a rigid crater is formed which may trap a small quantity of air or secretions, or both, and so in the erect position will show one or more fluid levels.

(e) Following on the above, the adherence of the peritoneal surface to adjacent structures so

that on respiration the normal gliding movement of one viscus on another is lost and deformation of the cap as a whole occurs.

(f) Penetration of the ulcer crater into adjacent structures. This sets up a strong reparative fibrosis and considerable deformity results. The best example is that of penetration into the pancreas, in which a typical V-shaped deformity is present with the ulcer crater at the apex of the 'V.'

(g) Stenosis of the lumen of the cap due to cicatricial changes. Severe degrees of stenosis in the middle third of the cap are usually associated with a widely patent pylorus.

(h) The formation of distension pouches in the base of the cap proximal to the stenosis. These pouches may be large and in certain cases may simulate the cap itself. Basal pouches may, however, be found in cases where no great stenosis is present and probably result from cicatricial changes having occurred in a large cap, the resulting abrupt transition from a wide lumen to a narrow one giving the impression of pouch formation.

(i) Occasionally the crater is situated on the superior (or lesser curve) border of the cap. Supine films in such cases often show the ulcer to be on the posterior wall, and it is probable that there is fixity of the ulcer crater so that in the erect position the cap falls downwards and forwards, leaving the crater projecting on the superior border.

(j) Ulceration close to the pyloric canal may produce a funnel-shaped deformity of the base of the cap and the pylorus may be involved in the fibrosis.

(k) Ulceration in the base of the cap but at a measurable distance from the pylorus produces an asymmetrical base, the side affected being smaller than the unaffected side.

(l) Gross cicatricial changes and periduodenal adhesions may affect the whole of the cap which then presents as a small narrow channel joining the pylorus and superior duodenal flexure, which is of normal calibre (phthisis bulbi).

(m) Oddities such as ulceration on the opposed anterior and posterior walls—'kissing' ulcers.

In general the guiding rules are:

(1) To identify the pyloric canal. This may be extremely difficult in case of severe pyloro-duodenal deformity, particularly if the deformity could be due to pyloric neoplasm superimposed on a chronic juxta-pyloric ulcer.

(2) To determine whether or not the cap is deformed.

(3) To attempt to demonstrate its mucosal pattern.

Ulcer craters of recent origin on the anterior wall are a special problem. All ulcer craters may be filled with secretion at the commencement of

the examination and one is often surprised to find an easily demonstrable crater in the 'en face' view at the end of the examination where, at the beginning, one had seen nothing. Moreover, on the anterior wall any barium which has entered may be squeezed out by the compression cone or examining hand.

Mucosal Oedema and Duodenitis

In the presence of a recent duodenal ulcer surrounded by its large cushion of mucosal oedema it may fairly be said that the mucosa is undergoing the pathological process of inflammation. This is obviously most pronounced at the periphery of the ulcer and is presumably the result of an active repair mechanism coexisting with the irritant action of gastric secretions at the ulcer edges. It is essentially, as far as the radiologist is concerned, a local lesion in the cap. The problem arises as to whether this local pad of oedema was not, in fact, the precursor of the ulcer, a loss of viability having occurred at its centre and the traumata of food passage followed by digestion changes producing the crater. If such a case were to be examined before ulceration had taken place, and if the mucosal changes were generalized, then the radiological findings would be those of a generalized inflammation or duodenitis. It is in such an atmosphere of conjecture that the controversy over the clinical diagnosis of duodenitis has taken place. Without embarking on a discussion of this subject it can be said that the radiologist will from time to time encounter a case where there is an apparent thickening of the mucosal folds, a loss of definition of the mucosal pattern, a rapid transit of barium through the cap and no evidence of ulceration. What course is he to adopt? He is aware that such conditions have been shown to occur in the stomach and that the pathological entity of multiple superficial mucosal erosions following a toxæmia is well established. But that such a condition may persist over long periods unaltered and be associated with symptoms of similar duration is open to objections. If, on the other hand, duodenal ulceration is primarily a stress phenomenon with premonitory mucosal changes then it would be reasonable to suppose that degrees of the condition short of ulceration can exist.

It may be helpful to detail the circumstances in which the appearance of a duodenitis may be found, although in fact an ulcer is present or the appearances are artefacts. A small ulcer crater may not be found in the 'en face' view and the 'profile' view may be inadequate. It may be that the technique employed contributes to the poor visualization of the mucosa. For example, during the taking of the film to demonstrate the gastric mucosal pattern, the patient while supine may be

turned on to his left side. The gastric secretions rise into the antrum and if he is then brought into the erect position will remain trapped at this site. Subsequently the cap will be filled first by the gastric secretions and then by a mixture of secretions and barium. If initial delay in pyloric relaxation is present, with small quantities of barium only being transmitted, the whole picture will be that of a duodenitis. The appearances may, however, be greatly improved if the patient is returned to the supine position and lain on his right side, so that the gastric secretions rise to the fundus and several good quantities of barium pass through the cap. Then a completely normal appearance may be obtained. Alternatively, an ulcer crater which has become filled during the period of starvation by layers of altered secretions may become visible as these secretions are removed by the passage of barium in good amount. Finally, as noted before, an anterior wall crater may be emptied by the action of the compression cone.

Allowing for these pitfalls in diagnosis there still remains a small residue of cases in which there is an apparent duodenitis. It is the writer's personal practice to re-examine such cases in six weeks and again at three months. Some cases will then present as firm duodenal ulcers and it is open to question whether these ulcers have been missed or have developed. The residue which, in the writer's experience, amounts to only two or three cases per year, may be labelled duodenitis.

In the presence of a gross gastritis it is usual to find that the duodenal cap is also involved but the concept of gastro-duodenitis is probably best regarded as a separate entity from the isolated duodenal lesion noted above.

Follow-up Radiography

Radiographic estimation of the results of treatment is influenced by two factors. First, if the radiologist adheres to the principles outlined above he will not be forced into the position of assessing the size or condition of an ulcer crater which he has not seen or of which he has no permanent record. Secondly, there will be occasions on which his findings will be wrong. These errors will usually occur in cases of gross deformity where a puckering of the wall will be mistaken for an ulcer crater.

The value of such an estimation of progress is another matter. It is the writer's opinion that radiographic follow-up of recent duodenal ulceration in a cap which has undergone little cicatricial deformity is essential. Such patients may become symptom free after a week in bed and medical treatment. But radiographic evidence of an ulcer crater may persist for two months. The temptation to return to full work and worry is great and the physician is hard put to it to refuse the request

in a young person who feels well. The positive evidence of a persistent crater is his best weapon. On the other hand, in a patient who has a grossly scarred cap and in whom either a small crater or none at all has been demonstrated but in whom a confident clinical diagnosis of ulceration has been made, little is to be gained by progress radiography, unless it be to exclude an increase in the size of the crater or to estimate to what extent the ability of the stomach to empty its contents is being impaired. In all chronic cases it may be said that if symptoms persist the ulcer remains, and re-examination should have a specific object in view, such as final assessment prior to operation or final proof that a certain form of treatment is inadequate for a particular case. It is sometimes said that the physician does not always act on the radiological evidence of a still demonstrable crater. This is true, but it is usually the patient who is at fault. There are few men and women with controllable 'indigestion,' who can happily retire to bed for long periods while their personal difficulties, economic and social, multiply in their absence.

It will be seen, therefore, that the writer's position lies midway between the two extremes of automatic monthly follow-up and clinical assessment by experimental therapy. It is felt that the radiological services will best be utilized if the clinician familiarizes himself with the limitations of the method and the radiologist confines himself to objective reporting.

Statistics

From the clinicians' viewpoint the most important statistic would be one which told him how many inaccurate reports could be expected in a consecutive series of 100 cases. There is no means of arriving at such a figure. The writer believes that with the technique described competently performed, a very high level of accuracy is obtainable. It becomes a matter of some importance to the radiologist to demonstrate on films what he has seen and to present these films for discussion to other radiologists and clinicians for their opinions when difficulty arises. Provided that the examination is done fully it is perfectly feasible for a full discussion to take place, in the absence of the patient, and much as one would discuss the radiological changes in a static portion of the body such as a humerus or femur.

Statistics on the percentage of positive findings which any one radiologist finds during the course of a year or so are also subject to qualification. Agreement is not always possible on what is a pathological change, as has been noted in the case of duodenitis. Other changes which have not been fully discussed, such as gastric mucosal prolapse into duodenum, asymmetrical bulges in the

duodenal wall as an indication of vascular or pre-existing ulcerative lesions and 'changes suggesting multiple superficial erosions' may be brought into such series and therefore, in the opinion of some, invalidate the statistical deductions. Even if the radiologist were completely accurate his percentage positive finding rate would only indicate the efficiency of the clinicians in that particular hospital in sorting cases for X-ray investigation. This in turn would depend on the type of population with which the hospital is dealing and also on the ease or difficulty with which X-ray examination can be obtained.

Total incidence in certain population groups is another matter and the radiologist is hardly qualified to discuss them.

Tumours of the First Part of the Duodenum

All intrinsic duodenal tumours are rare but of those which are found the most common is the benign polyp occurring either singly or in small numbers. The majority of these polypi are simple adenomata, but the whole range of mucosal and submucosal benign tumours is reported, including aberrant pancreatic tissue. Their importance lies in their complications which include superficial ulceration with severe melaena, excessively rare intussusception and malignant change.

Of the malignant tumours, carcinomatous ulcers and sarcomas arising from the tissue elements of the submucosa and muscular layers are very infrequently reported. In this connection it may be remarked that the gastro-duodenal junction appears to form a very effective barrier against the spread of gastric carcinoma, it being a frequent finding that a gastric carcinoma apparently arising close to the pylorus and spreading extensively into the body or even the fundus of the stomach is completely delimited by the duodenum. True spread into the duodenum is a pathological rarity.

Duodenal Fistulae

A rare and usually unexpected finding is the demonstration of a track of barium leading from the duodenal cap into the biliary passages, or the presence of air in these passages. Such fistulae may arise from inflammatory or obstructive lesions in the gall bladder, less commonly the common bile duct with adhesion to and perforation into the first or second parts of the duodenum. Approximately half of all cases of internal biliary fistulae are between the gall bladder and duodenum. Fistulae between the duodenum and practically all the abdominal organs except the rectum and bladder have been reported.

Specific Infections

Tuberculous involvement of the duodenum may

be part of a general intestinal tubercle or secondary to caseating lymph nodes in the pre-aortic and paraduodenal areas. Actinomycotic infections are exceptionally rare.

The Duodenal Cap in Infancy and Children

Radiological examination of the stomach and duodenum in infancy is commonly initiated to exclude or confirm pyloric musculature hypertrophy or congenital duodenal stenosis. The latter condition is rare in the first part of the duodenum but considerable dilatation may occur at this site secondary to stenosis in other portions of the loop. Several cases of duodenal ulceration in infancy radiologically diagnosed (as opposed to autopsy findings) have been reported. The writer has not been in a position to see such cases but has noted a number of patients in the age group 16 to 18 with duodenal ulceration who date

their symptoms from three or four years earlier.

Summary

The technique of radiological examination of the first part of the duodenum has been discussed and the findings in duodenal ulceration have been described. The benefit to be obtained from liaison between radiologist and clinician has been stressed.

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MAMMARY TUBERCULOSIS

Critical Discussion with an Illustrative Case

By DUNCAN M. FORREST, F.R.C.S., and RAYMOND PARKES, M.B., Ch.B.

From Harefield Hospital, Middlesex

Introduction

This paper was intended originally as a short record of a case of mammary tuberculosis, but, finding that the considerable number of reports on the disease that have appeared (from all parts of the world) since the classical description of Sir Astley Cooper in 1829 have tended to be confusing, uninformative and, occasionally, positively misleading, we have thought it worth while discussing the matter in greater detail.

That the disease seems rarely to have been described by workers in the field of tuberculosis but often by surgeons who, naturally, have tended to approach it as a local problem, has, we believe, been responsible for its isolation and incomplete study from the standpoint of pathogenesis in particular.

Clinical Characteristics

Incidence

Mammary tuberculosis is uncommon though not rare. Morgen (1931), in a careful review, claimed to find 439 cases recorded between 1829

and 1931, and within four years McGehee and Schmeisser (1935) believed that, with their own cases, the total was 535; between 1920 and 1942 Klossner found 50 cases (none of which were included by the previously mentioned authors) in Finland. However, it is almost certain that the number of cases occurring is significantly greater than the number reported, and so many single cases and small series have now appeared in the world literature that it is pointless to continue enumerating them.

The incidence is most commonly expressed as a percentage of all breast diseases and there is little difference in various estimations: 1.04 per cent. (of all breast diseases operated upon at the Presbyterian Hospital, Chicago (Gatewood, 1916)), 1.5 per cent. (24 cases of tuberculosis from 1,587 patients with breast pathology at St. Bartholomew's Hospital, London, between 1890 and 1903 (Scott, 1904)), 1.78 per cent. (8 in 447 cases of breast disease at Memphis General Hospital from 1922 to 1934 (McGehee and Schmeisser, 1935)). It will be seen that tuberculosis probably repre-